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Environmental response indicators for the industrial and energy sector in Flanders

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Abstract

Environmental reporting with quantitative indicators is becoming popular worldwide. However, environmental response indicators, which describe the reaction of societal actors to environmental problems and to government policy, still remain under investigation. This paper describes the collection of potential response indicators for the industry and energy sectors in Flanders, the quality assessment, and the identification of a core set of suitable response indicators. The selected core set consists of four indicators: eco-efficiency (a mainstream indicator for decades), the presence of an environmental management system, the amount of environmental expenditures and the use of sustainable energy. This core set is applied to the Flemish situation in order to assess the environmental performance of the industry and energy sectors. The core set allows identification of areas where the industry and energy sectors are performing better than other sectors, as well as areas where additional efforts are needed.

Keywords: Environmental performance evaluation; Response indicators; Industry and energy; Eco-efficiency; EMS

1. Introduction

Environmental reporting is one of the key elements in environmental policy. Use of quantitative indicators is essential in environmental reporting because they supply unbiased information on environmental problems, they support policy development and priority setting, they monitor the effect of policy responses and they raise public awareness [1]. Companies use indicators to evaluate their environmental performance and to identify areas for improvement [2,3]. A core set of indicators simplifies some aspects of our understanding of what we think is the state of the environment to a level that humans can grasp the situation and can take measures to influence the evolution. In order to classify indicators, several frameworks have been proposed.

The OECD developed the Pressure-State-Response framework in the late eighties [4], the UN adapted it to the Driving force-State-Response framework [5], and the European Environment Agency (EEA) eventually opted for the Driving force-Pressure-State-Impact-Response (DPSIR) framework [6].

The DPSIR framework organises the relationship of humans to the environment in a system of driving forces (D) that exert pressures (P) on the environment, resulting in a certain state (S) of the environment, as shown in Fig. 1. This state has an impact (I) on humans, nature and the economy, which

Abbreviations: Aeq, acid equivalent; CO_2-eq, CO_2 equivalent; COD, chemical oxygen demand; DMI, direct material input; DPSIR, Driving force-Pressure-State-Response; EEA, European Environment Agency; EMAS, Eco-Management and Audit Scheme; EMS, environmental management system; GAV, gross added value; GIP, gross interior product; GRI, Global Reporting Initiative; ISO, International Organization for Standardization; MVO, Maatschappelijk Verantwoord Ondernemen (responsible enterprising in society); OECD, Organisation for Economic Co-operation and Development; PCB, polychlorinated biphenyls; PRI, potential response indicator; RDF, refuse derived fuel; SRI, selected response indicator; UN, United Nations; VMM, Vlaamse Milieumaatschappij (Flemish Environmental Agency); VOC, volatile organic compounds; W&E, waste and emissions.

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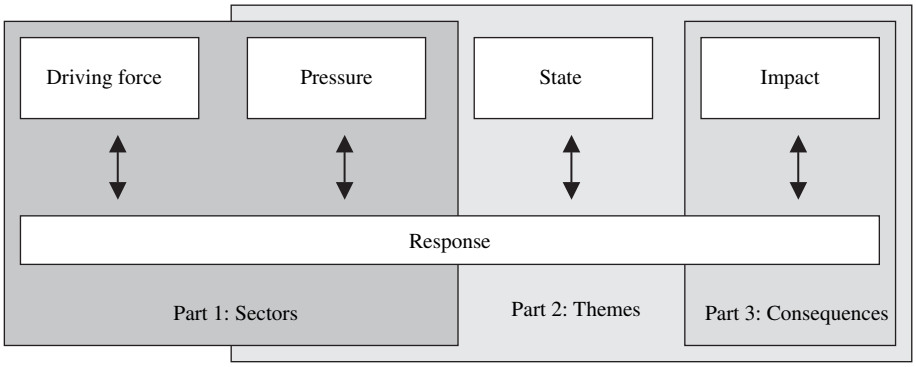

Fig. 1. DPSIR framework with additional classification of the Flemish government.

may stimulate responses (R) from society on any of the four previous elements [1]. With respect to the structure of their environmental reports, the Flemish government has identified three main parts within this DPSIR framework: sectors, themes and consequences [7]. Sectoral reporting encompasses eight driving forces (material flows, population, industry, energy, agriculture, transport, trade and services, and tourism and recreation) and the resulting pressures. Thematic reporting focuses on pressure, state and impact for a specific environmental issue (e.g. VOCs and PCBs). The report on consequences investigates the integrated impact of several environmental issues on humans, nature and economy.

Indicators for driving forces, pressure, state and impact have been extensively collected and investigated. The number of response indicators, however, remains limited. Table 1 gives an overview of the number of indicators in reports from the Global Reporting Initiative (GRI), which is affiliated to the UN, the EEA and the Flemish Environmental Agency (VMM). Although the number of response indicators is in line with the number of other indicators (D, P, S, and I), there is still need for more response indicators, because they feed back to each of the four system elements. Certainly in the Flemish context, where only 2 out of 13 response indicators are applicable to industry and energy, it is the authors' opinion that more response indicators should be identified.

To date there is no clear definition for response indicators. We define response indicators as indicators that describe how society reacts to environmental problems. The actors in society are the government, professional bodies (industry, agriculture, etc.) and the population. The reactions include the response of the government on the environmental problem, the response of the other actors on the environmental problem, and the response of the other actors on government policy. Although reporting of response indicators may not directly influence the actor in his decision-making, it is the authors' opinion that it will have an indirect effect on the actor and his decisions in the longer term, by guiding the whole society on its way to industrial ecology.

Table 1
Number of indicators in environmental reports

	GRI[a]	EEA[b]	VMM[b]
Driving forces	0	7	13
Pressure	16	9.5	54
State	6	10	47
Impact	6	3	37
Response	7	7.5	13
Total	*35*	*37*	*164*

[a] GRI Environmental performance indicators exclude driving forces and do not define their indicators along the DPSIR framework; classification is performed by the authors.

[b] An indicator may be classified into two categories and is then counted as a half unit in each category.

The most recent environmental report in Flanders gives information on 49 indicators for the sectors, 99 indicators for the themes and 16 indicators for the consequences [8]. The EEA also distinguishes between sectors and themes, with 13 indicators for sectors and 24 indicators for the themes. To date, however, the EEA core set of indicators covers only four sectors (agriculture, energy, fisheries and transport). Indicators for additional sectors such as industry and material flows are the main focus for the future development of the EEA core set [1].

The focus of this paper is the behaviour of two actors in society – the sectors industry and energy – towards the environmental problems and governmental environmental policy. Potential response indicators are reviewed and assessed based on the EEA methodology, in order to define a core set of response indicators for the sectors such as industry and energy. The selected core set is then applied to the Flemish situation. The industry and energy sectors are defined according to the classification currently used in Flemish policy [8]. The industry sector includes the mining, food, textile, wood, polymer and construction subsectors (NACE-BEL 15–22, 24–37, 41 and 45). The energy sector includes the petroleum refining, electricity and gas producing subsectors (NACE-BEL 10–12, 23, and 40). The sectors such as population, agriculture, transport, trade and services, and tourism and recreation are not included in this investigation.

2. Methodology

An extensive review is performed to collect potential response indicators (PRIs) for the industry and energy sectors [9]. This review is based on various reports concerning environmental reporting [10–15], as well as on practical expertise

from a number of companies in the industry and energy sectors in Flanders. A first evaluation concerns the question whether the gathered indicators are response indicators. This evaluation is inevitably qualitative in nature, due to the generality of the definition of response indicator, which hampers a clear interpretation. Also, indicators in which major drawbacks were obvious were discarded during this first assessment.

Once potential indicators are collected, the quality of (response) indicators is assessed based on several criteria. Both EEA [16] and VMM [8] define six criteria for the selection of a suitable indicator:

- *policy relevance*: the indicator illustrates what is perceived as an environmental issue;
- *target reaching*: the indicator allows to assess policy targets;
- *methodology*: the indicator can be scientifically quantified, based on a well founded method;
- *availability*: the data for the indicator are readily available and routinely collected;
- *spatial coverage*: the indicator is applicable to the whole country or region; and
- *temporal coverage*: the indicator illustrates continuous or semi-continuous (i.e. discrete data, but frequently sampled) data.

Potential indicators can be assessed on the basis of these criteria by giving them a score from zero to four. The requirements for each score have been defined by the EEA [16] and were adapted to the Flemish context (Table 2). After making an inventory of PRIs, a core set of indicators can be defined. In this core set of indicators, some PRIs were eliminated because they were so similar to each other, whereas other PRIs were retained because they illustrate a part of the environmental field not yet covered by the other indicators. In literature indicators have been classified according to typology (a. descriptive, b. performance, c. efficiency and d. total welfare indicators) [1] or dimension (a. technical, b. economic and c. social) [12,17,18]. When defining the final set of indicators, a wide variety within typology and dimension is preferred [18], e.g. to account for the large financial efforts one has invested (i.e. economic parameter) resulting in only a small technical improvement in a process (i.e. technical parameter). Therefore, this approach has been used to decide which PRIs form the core set of indicators.

3. Identification of PRIs

In total 14 indicators were selected. Five of them were discarded, because they had important drawbacks, which are given in Table 3. After this qualitative assessment, nine PRIs remained.

3.1. Eco-efficiency

The indicator eco-efficiency has been used in environmental reporting for decades, even long before it has been labelled ‘eco-efficiency’. Although eco-efficiency is being regarded in Flemish environmental reports [8] as a combination of a driving force and a pressure in the DPSIR framework, it is actually the reaction of the sector on economic and environmental reality. It is, therefore, considered a sectoral response acting upon the pressure of raw material input and waste/emissions’ output. Eco-efficiency is most often defined as the (added) economic value of a product or activity divided by the (added) environmental impact of that very product or activity [11]. The way to quantify the economic value and the environmental impact depends on the exact product or activity one wants to investigate. Therefore, we define eco-efficiency from the ‘‘material input’’ point of view and from the ‘‘product output’’ point of view. The latter is the industrial product in the industrial sector and the energetic output in the energy sector. This results in three types of eco-efficiency:

i. material productivity (both for the industrial and energy sector) = economic value of the product/the amount of direct material input (in euro/ton);
ii. product productivity (industrial sector) = economic value of the industrial product/the amount of waste and emissions (in euro/ton);

Table 2
Methodology used for quality assessment of potential indicators

Criteria	0	1	2	3	4
Policy relevant	Not a Flemish policy issue	–	–	–	A Flemish policy issue
Target reaching	No targets	Targets but the indicator do not fully reflect these	Qualitative targets (generic)	Qualitative targets (specific) or quantified targets not time bound	Quantified targets time bound
Methodology	No methodology description	Major improvements needed	Minor improvements needed	–	Well founded with references
Availability	Not ready available	Some data available, but missing collection procedures	Ad hoc data or from non-governmental sources	–	Collection by Flemish governmental institutions
Spatial coverage	–	Data from some point sources	Data from half of sources	Data from 2/3 of sources	Data from nearly all sources
Temporal coverage	–	Only data from one to three years	Trend four to nine years	Trend longer than 10 years	Trend longer than 10 years for most sources

Table 3
Overview of discarded indicators with their main drawbacks

Discarded indicator	Drawback
Use of surface area	Not a response indicator
Ecological footprint	Based on the environmental impact caused by individuals, not by specific industrial processes
Weight proportion of recyclable parts of sold products	Requires extensive information, which is not available
Cleaned soil vs. total polluted soil	Cannot be completely attributed to existing industry (historical pollution), cleaning is also often imposed by government
Use of products from companies with an environmental management system (EMS)	No EMS-produced alternatives exist for all product types

iii. energy productivity (energy sector) = economic value of the energetic output/the amount of waste and emissions (in euro/ton).

In Flanders, the economic value of the industrial production is usually quantified by the industrial production index, which is a business cycle indicator showing the output and activity of the industrial sector [19]. The economic value of the energy sector is quantified by the energetic output, which is the sum of the energy content of produced electricity, gas and other energy sources [8]. Both the production output and the energetic output are shown as an index relative to a reference year. The direct material input and waste/emissions can be represented by referring to different parameters (e.g. water consumption, emission of greenhouse gases or heavy metals). The eco-efficiency indicator is therefore not a single number, but rather a collection of numbers.

3.2. Reclaimed material

"Reclaimed" refers to either the recycling or reuse of waste materials as secondary raw materials. The indicator gives the proportion of the amount of secondary raw material to the total input (i.e. the sum of primary and secondary raw materials).

3.3. Environmental management system (EMS)

This indicator illustrates the presence of EMS in the industry and energy sectors. In order to include the size of the enterprise, the indicator is based on the "gross added value" (GAV). The indicator is defined as $GAV_{\text{enterprises having EMS}}/GAV_{\text{total for sector}}$. In Flanders, two types of EMS are in use:

i. ISO 14001 [20].
ii. EMAS [21].

In 1992, the European Union established the EU eco-label, which is a certification scheme for products, and services (not including food and medicine) that are more environmentally friendly than equivalent products and services. The difference with EMS is that eco-labelling schemes focus on the specific products or services of the firm, whereas EMS is focused on the general environmental performance of the company. Eco-labelling is less applicable to the whole industrial sector, since it focuses on the products available to private consumers. It is, therefore, not included in this indicator.

3.4. Environmental expenditures

The environmental expenditures include the operational expenditures and the environmental investments but exclude the expenses for taxes and other policy instruments.

3.5. Size of the environmental department

The indicator is defined as the number of people in the environmental departments of the companies within a specific sector relative to the total number of people in the sector.

3.6. Sustainable energy

This indicator focuses on efficient energy consumption and renewable energy, as alternative to the conventional energy production from fossil fuels and nuclear fission. Two policy instruments are included in this indicator:

i. governmental support for green electricity production from renewable energy sources; and
ii. governmental support for cogeneration of both heat and electricity in total energy power plants.

3.7. Taxes and subsidies

Several departments of the Flemish government levy environmental taxes (on solid waste production, wastewater production, and groundwater consumption). The government also subsidizes several activities, such as measures for rationalizing energy consumption, prevention of waste and tax deductions for energy-saving investments. The indicator is defined as the total value of subsidies minus the total value of taxes.

3.8. Complaints/warrants

The indicator is defined as the number of official complaints to the Environmental Inspection Department of the Flemish government. The number of official warrants can also be represented.

3.9. Responsible enterprising in society

Business & Society Belgium, a network of companies and federations in Belgium, has initiated in 2005 the MVO-barometer ("Maatschappelijk Verantwoord Ondernemen", i.e. "Responsible enterprising in society") [22], a questionnaire sent to large companies to determine how they perceive their actions with respect to the environment. Of the 976 contacted

Table 4
Quality assessment of PRIs for the sectors industry and energy

No.	Indicator	Policy relevance	Target reaching	Methodology	Availability	Spatial coverage	Temporal coverage	Total score	Type[a]	Dimension[b]
1.	Eco-efficiency	4	2	4	4[c]	4	4	22	E	T
2.	Reclaimed material	4	2	2	4	4	4	20	D	T
3.	EMS	4	2	2	2	4	2	16	P	T
4.	Financial expenditures	4	2	4	4	4	2	20	D	E
5.	Size of the environmental department	0	0	1	1	1	1	4	D	T
6.	Sustainable energy	4	4	2	4	4	1[d]	19	D	E
7.	Taxes/subsidies	4	1	1	2	4	4	16	D	E
8.	Complaints/warrants	4	2	1	4	4	2	17	P	S
9.	Environmentally responsible enterprising	4	2	2	2	1	1	12	P	S

[a] D = descriptive, P = performance, and E = efficiency.
[b] T = technical, E = economical, and S = social.
[c] Material productivity scores only two for availability.
[d] Total energy certificates score zero for temporal coverage, as the first results will only be available from 2006 on.

companies, 128 responded. The results can be classified into the Belgian regions (Flanders, Wallonia and Brussels). The intention is to make this initiative an annual event and to include small and medium-sized companies as well. The aim of Business & Society Belgium is to show that companies become increasingly more concerned about the state of the environment and adapt their policy accordingly.

These nine PRIs are assessed hereafter following the six criteria. All PRIs are *relevant* with respect to Flemish policy (score of four), except for the ''size of the environmental department'' (score of zero), the link of which with cleaner production is not straightforward and as such not a policy issue. Most PRIs have only generic qualitative *targets* (e.g., be as high as possible, score of two). The ''size of the environmental department'' is not supported by a target (score of zero), because it is impossible to define an optimal size. For sustainable energy, the government has defined quantitative time-bound targets (given in Section 4.4, score of four). The *methodology* for ''eco-efficiency'' and ''environmental expenditures'' is already well investigated (score of four): the former in international reports [11,14], the latter on the national level [23,24]. PRIs with a methodology score of one have serious flaws in their definition. This is the case for the ''size of the environmental department'', where there is no clear method on how to objectively count people who combine environmental aspects with safety aspects in their jobs. Some companies are also formally required to have an environmental coordinator, who affects the result of the indicator. With respect to ''taxes and subsidies'' (also with a score of one on methodology), it is not clear whether all subsidies can be summed (some subsidies are in the form of tax deduction). Concerning ''complaints/warrants'' (third PRI with a score of one on methodology), people have become more outspoken which increases the number of complaints, without necessarily implying that more environmental offences are committed. Data on ''eco-efficiency'', ''financial expenditures'', ''sustainable energy'' and ''complaints/warrants'' are readily *available* in Flemish governmental institutions (score of four). Data on ''reclaimed material'' were up to 2004 collected by the government, but formal registration, and thus collection, is not needed anymore since 2005. By consequence, the availability of these data will decrease drastically (score of four, but will decrease to one in the near future). The ''size of environmental divisions'' is not well documented (score of one). The *spatial coverage* is high for all PRIs (score of four), except for the ''size of the environmental department'' (no data available, score of one) and ''responsible enterprising in society'' (only 13% of large companies in Belgium have responded to the questionnaire [22], score of one). ''Eco-efficiency'', ''reclaimed material'' and ''taxes/subsidies'' have been documented for

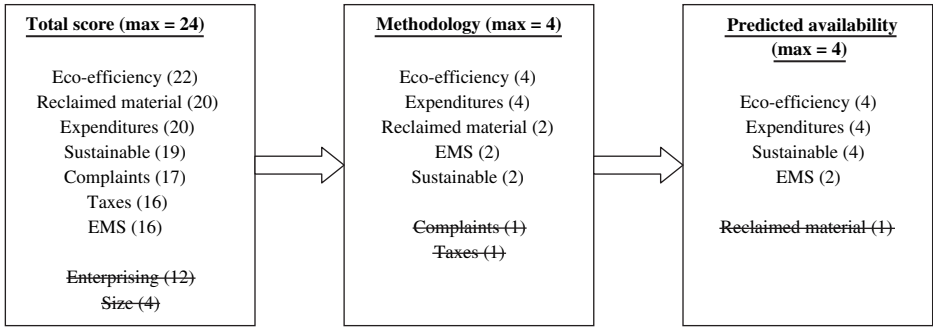

Fig. 2. Classification of PRIs and selection of SRIs.

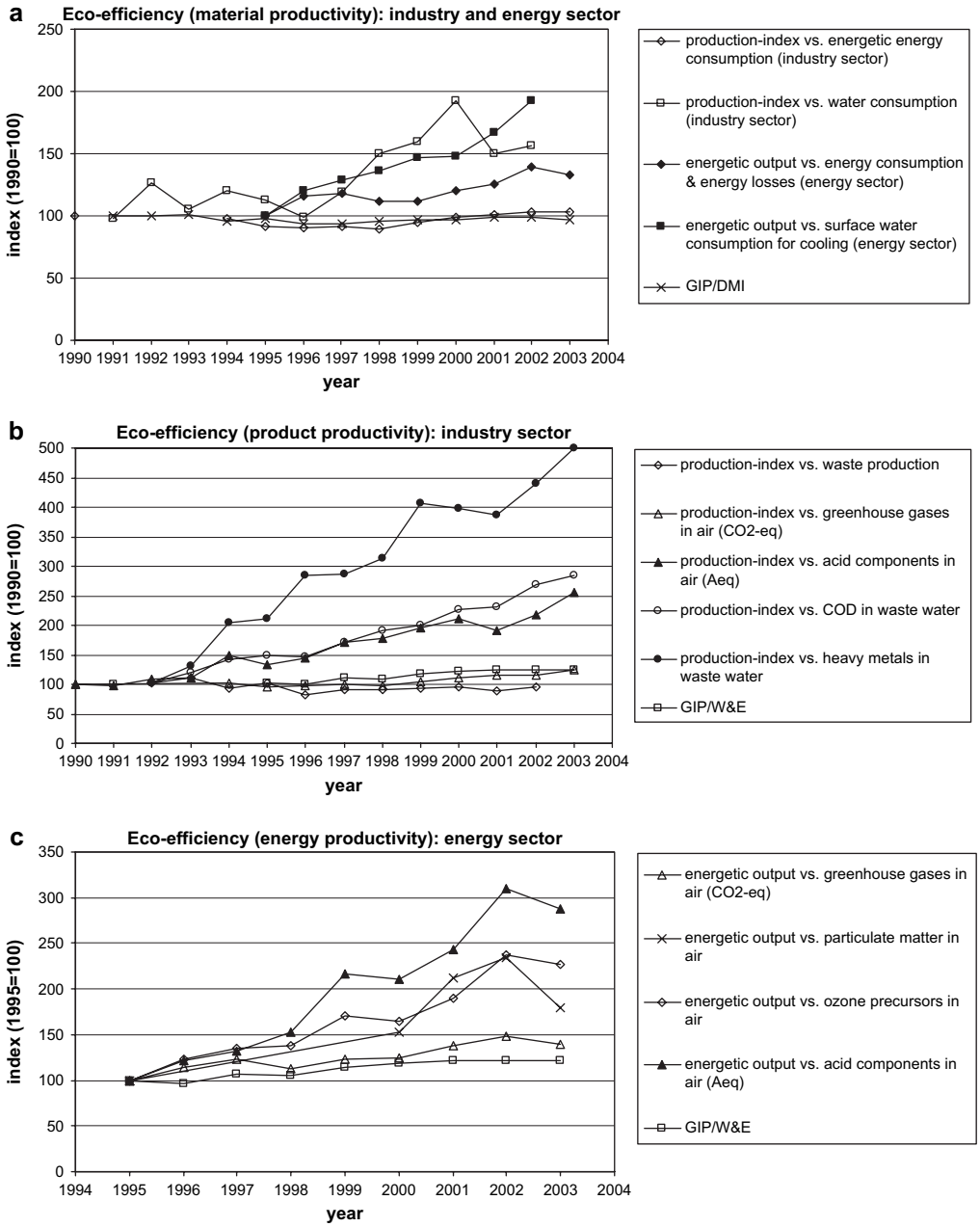

Fig. 3. Different types of eco-efficiency: (a) material productivity: GIP/DMI covers all sectors and is relative to 1991, data of industry sector are relative to 1990, data of energy sector are relative to 1995; (b) product productivity: GIP/W&E covers all sectors and is relative to 1991, data of industry sector are relative to 1990; (c) energy productivity: GIP/W&E covers all sectors and is relative to 1995, data of energy sector are relative to 1995. CO_2-eq = the sum of greenhouse emissions expressed in CO_2 equivalents, based on the greenhouse warming potential (GWP) of greenhouse gases; $GWP_{CO_2} = 1$,$GWP_{CH_4} = 23$,$GWP_{N_2O} = 296$, $GWP_{SF_6} = 22200$, $GWP_{HFC} = 12 - 12000$, $GWP_{PFC} = 5700 - 11900$ [25]. Aeq = the sum of acid emissions expressed in potential acid equivalents; 1 mol SO_2 can produce 2 mol H^+ during hydrolysis, whereas 1 mol NO_x and 1 mol NH_3 can each produce 1 mol H^+.

more than 10 years (score of four), whereas the *temporal coverage* of ''sustainable energy'' and ''responsible enterprising in society'' is only two years or less due to their recent origin (score of one). Data for the other PRIs are available since five to six years (score of two). Overviews of the assessment results in this paragraph are shown in Table 4, together with the classification of the PRIs according to typology and dimension.

The maximum score on the total of six criteria is 24. We consider a score of more than half of the maximum score (>12) as a minimum requirement for inclusion of the indicator in the core set of indicators. Because PRIs with a score of <2 on methodology need major methodological improvements, these are not included in the core set. Although ''reclaimed material'' appears to be a suitable indicator (total score of 20), this indicator is not included in the core set because it is assumed that the data availability will decrease drastically after 2004.

Four suitable response indicators (SRIs) are thus identified and presented in Fig. 2: eco-efficiency, EMS, environmental

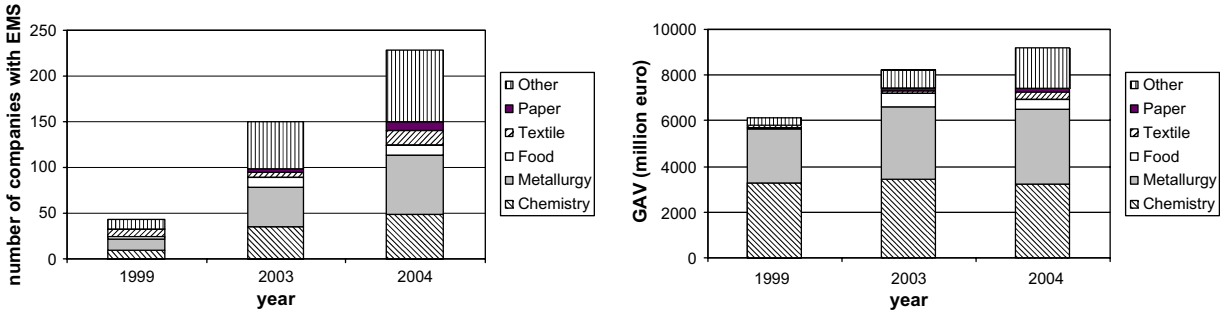

Fig. 4. Number of ISO and EMAS certificates in industry (left) and total GAV of certified companies in industry (right).

expenditures and sustainable energy. Two of them are descriptive indicators, one is a performance indicator and the other one is an efficiency indicator. Two indicators illustrate technical dimensions, whereas the other two focus on the economic side. This SRI core set already covers a wide variety of indicator types. Only the social dimension and total welfare indicators are missing in the core set. In the future, ''Responsible enterprising in society'' might be included in the core set if its total scores increase, e.g. by increasing spatial and temporal coverage. This would add a performance indicator and social dimension to the core set.

4. Core set of SRIs

4.1. Eco-efficiency

The overall material productivity in Flanders is expressed in gross interior product/the amount of direct material input (GIP/DMI), because no production index is available for sectors other than industry. Fig. 3 shows that overall material productivity has not increased since 1991. Both the industry and the energy sectors, however, have increased their material productivity (expressed as production index or energetic output per energy or water consumption) since 1995 with respect to water consumption. In the energy sector there has also been an increase in energy output vs. energy consumption, which is not visible in the industry sector.

Similar to the overall material productivity, the overall product productivity in Flanders is expressed as gross interior product/the amount of waste and emissions (GIP/W&E). It has increased by 25% since 1990. The product productivity in the industry and the energy productivity in the energy sector (expressed as production index or energetic output per amount of waste and emissions) have increased to a larger extent: the discharges of COD and heavy metals in industrial wastewater and the emissions of acid forming components, ozone precursors and particulate matter to the air are disconnected from the industrial or energetic output. The emissions of greenhouse gases decreased compared to the produced output. Only the production of waste by the industry has worsened relative to the production index. Overall it seems that the industry and energy sectors perform better than the average eco-efficiency of all sectors together. The industrial sector has to focus on energy consumption and waste production for further efficiency improvement.

4.2. EMS

Two types of environmental management systems are present in Flemish companies: ISO 14001 and EMAS. Due to the stricter requirements, the higher cost and the compulsory publication of auditing results, EMAS is less popular than ISO 14001: only 4% of the registered EMS in Flanders in 2004 was of the EMAS type. Fig. 4 shows that the number of EMS certified companies has increased steadily. The metallurgical subsector has the largest number of companies with an EMS in 2004, followed by the chemical subsector. When expressing the importance of EMS in the total GAV of the companies that have an EMS, the relative importance of the chemical subsector increases to the level of that of the metallurgical subsector. The slower increase in total GAV from 1999 to 2004 relative to that of the number of EMS certifications indicates that since 1999 mainly small and medium-sized

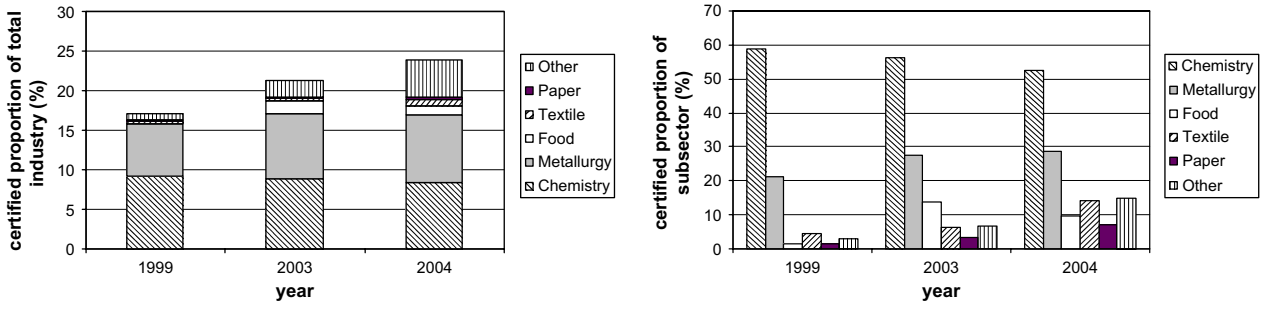

Fig. 5. GAV proportion of certified companies to the total sector (left) and to the total subsector (right).

enterprises are implementing EMS. In order to further increase the presence of EMS in subsectors that consist mainly of small and medium-sized enterprises (e.g. food), financial or other compensation should be considered.

In 1999, 17% of all industrial companies were certified, as shown in Fig. 5. This fraction increased to 24% in 2004. The chemical subsector has done the main effort: in 2004, 53% of the sectoral GAV is generated in companies with an EMS. In the metallurgy GAV is 29% and 14% in the textile industry and 10% in the food subsector.

4.3. Environmental expenditures

Although the total expenditures by the industry for environmental protection measures have increased in absolute numbers from 2230 million euro in 1997 to ca. 2550 million euro in 2000 [23], the relative share in total expenditures has decreased. Fig. 6 shows this evolution. This is mainly due to the decreasing proportion of investments, whereas operational expenses remain relatively constant. The energy sector (1.56%) and chemical subsector (0.99%) performed better than average (0.61%) with respect to the operational expenses. For the investments, the energy sector (2.3%) and the metallurgical (6.7%), chemical (4.5%), wood (2.1%) and food (2.0%) subsectors of the industry performed better than average (1.15%). Operational expenses are mainly spent on waste (66% of total environmental operational expenses in 2000) and water (17%), whereas investments are focused on water (56% of total environmental investments in 2000) and waste (30%). The decreasing investment proportion for environmental protection by the industry is worrying for industrial pollution in the long term.

4.4. Sustainable energy

4.4.1. Green electricity

The Flemish government defines electricity from renewable energy sources, such as solar and wind energy, water power, biomass and landfill gas, as ‘‘green electricity’’. Time-bound targets for green electricity consumption have been set for electricity providers. The production of green electricity started in Flanders in 2002 and increased from 2002 to 2004 by a factor of 3.6. Data are shown in Fig. 7. The proportion of green electricity to total electricity, however, has not achieved the targets. Possibly the recent inclusion in green electricity of electricity produced from refuse derived fuel (RDF) will increase the green proportion to above the target.

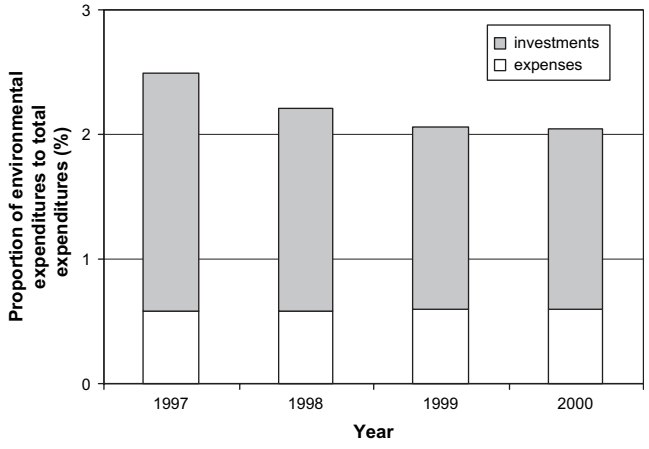

Fig. 6. Environmental expenditures by the industry as a proportion of total expenditures.

4.4.2. Cogeneration of electricity and heat in total energy power plants

Since 2005 the government defines electricity produced in total energy power plants (e.g., steam and gas turbines) where power and heat are cogenerated, as total energy. In future, electricity providers will have to use electricity from total energy for a minimum share of the total electricity production. Time-bound targets have been defined: 1.19% in 2005, 2.16% in 2006, and then gradually increasing to 5.23% in 2010. The system is comparable to green electricity. The first data are expected in 2006.

5. Conclusions

In environmental reporting, indicators that describe the response of industrial and energy companies to environmental problems and to the environmental policy of the government are still too much overlooked. These so-called response indicators are, however, needed to evaluate the measures taken by government and by the companies themselves. Growing attention and use of response indicators illustrates society’s evolution towards industrial ecology.

The search for and evaluation of response indicators were performed within the Flemish situation. Nine potential response indicators were assessed with respect to their quality based on EEA criteria. A core set of four, and in future possibly five, suitable response indicators have been selected: eco-efficiency, the presence of an environmental management system, the amount of environmental expenditures and the use of sustainable energy. An annual questionnaire on responsible enterprising may complement these four indicators in future. This core set covers as much as possible the technical, economic and social dimensions of the environmental aspects of industry. Various types of indicators are represented in the core set: descriptive, performance and efficiency indicators. This wide variety within the core set guarantees a broad coverage of the environmental field.

The methodology presented in this paper can be used in other countries as well. Implementation of the methodology in the Flemish context has resulted in the core set described above. Performing the same exercise in a different country might well yield another core set. In the long term, however, definition of an internationally relevant core set of response indicators should be the objective.

Application of the four suitable response indicators in the Flemish context shows that the industry and energy sectors are working hard to improve their environmental behaviours. Their eco-efficiency is higher than the average eco-efficiency

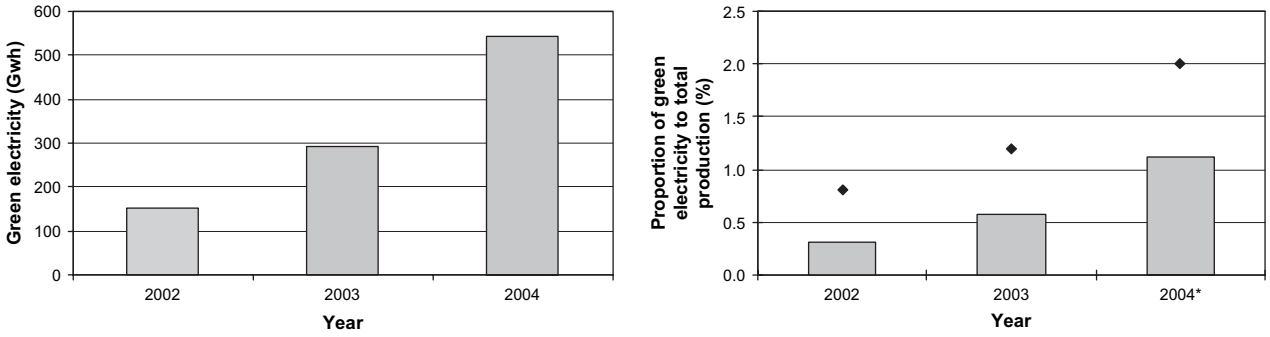

Fig. 7. Production of green electricity (left) and proportion of green electricity in the total electricity production with targets as diamonds (right). The proportion in 2004 is based on provisional data of the total electricity production.

of all sectors together. Waste production by the industry, however, is increasing more than the production index and should be a major focus. The energy use efficiency by industry also requires improvements. A significant proportion of the large enterprises have already implemented an environmental management system. In order to increase the number of implementations in small and medium-sized enterprises, the government should consider (financial) stimulants. A worrying evolution is the decreasing investment proportion for environmental protection. The production of sustainable energy is increasing but its importance still remains limited.

Based on this evaluation, the authors urge industry to invest more on environmentally friendly processes, in particular with respect to waste production. The Flemish government should support companies to focus on the environmental aspect of their activities by financially stimulating both these industrial investments and the adoption of environmental management systems. Research institutions are invited to use the described methodology in their country or area in order to help develop and utilize an internationally based core set of response indicators.

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